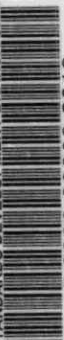


STANDARDS DEVELOPMENT BRANCH OMOE



3 6936 00000 2016



Air Quality in Ontario 1988

TD
883.7
.C3
O5
A5
1990
MOE



Ontario

Environment
Environnement

Jim Bradley, Minister/ministre

MINISTRY OF THE ENVIRONMENT

MAY 25 1988

HAZARDOUS CONTAMINANTS
BRANCH

STAIR
1
TORONTO, ONTARIO M4V 1P5
NCH

©Queen's Printer for Ontario, 1990
ISSN 0840-9366

TD
883.7
.C3
O5
A5

Air quality in Ontario 1988 : a
review of the air quality
monitoring program /

18214

ERRATA

The following corrections should be noted and applied to the report entitled " Air Quality in Ontario 1988 ":

- a) on page 3, paragraph 6 O_2 should be replaced by O_3 .
- b) on page 3, paragraph 8 NO_4 should be replaced by SO_4 .
- c) on page 7, Table 1 number of 1-hour SO_2 exceedances at Copper Cliff should read 85, not 6.
- d) on page 15, Table 5 highest geometric mean for Pb at Mississauga should read 1.87, not 2.0 .

AIR QUALITY IN ONTARIO 1988

A review of the air quality monitoring program

TABLE OF CONTENTS

EXECUTIVE SUMMARY	2
INTRODUCTION	3
SECTION A - POLLUTANTS MEASURED BY CONTINUOUS MONITORING (HOURLY DATA)	
1. Sulphur Dioxide (SO ₂)	4
2. Suspended Particles (SP)	4
3. Total Reduced Sulphur (TRS)	5
4. Carbon Monoxide (CO)	5
5. Hydrocarbons (THC/RHC)	5
6. Nitrogen Dioxide (NO ₂)	6
7. Nitric Oxide (NO)	6
8. Total Nitrogen Oxides (NO _x)	6
9. Ozone (O ₃)	6
SECTION B - THE ONTARIO AIR QUALITY INDEX	
10. Air Quality Index (AQI)	9
11. Air Pollution Index (API)	9
SECTION C - POLLUTANTS MEASURED BY HIGH VOLUME SAMPLER (DAILY DATA)	
12. Total Suspended Particulates (TSP)	13
13. Lead (Pb)	13
14. Trace Metals (Cadmium, Chromium, Copper, Iron, Manganese, Nickel, Vanadium)	14
15. Nitrate (NO ₃ ⁻)	14
16. Sulphate (SO ₄ ²⁻)	15
TABLES	
1. Highlights of Continuous Monitoring (1988)	7
2. Air Quality Index Pollutants and Their Impact	10
3. Air Quality Index Summary June to December (1988)	10
4. Ten-Year History of the Air Pollution Index (1979 - 1988)	11
5. Highlights of Particulate Monitoring (1988)	15
FIGURES	
1. Ten-Year Trend in Continuous Pollutants SO ₂ , SP, CO and TRS	8
2. Ten-Year Trend in Continuous Pollutants THC, NO ₂ , NO and O ₃	8
3. Ten-Year Trend in Particulate Pollutants TSP, Pb, Cu and Fe	16
4. Ten-Year Trend in Particulate Pollutants NO ₃ ⁻ and SO ₄ ²⁻	16

Copyright Provisions and Restrictions on Copying:

This Ontario Ministry of the Environment work is protected by Crown copyright (unless otherwise indicated), which is held by the Queen's Printer for Ontario. It may be reproduced for non-commercial purposes if credit is given and Crown copyright is acknowledged.

It may not be reproduced, in all or in part, part, for any commercial purpose except under a licence from the Queen's Printer for Ontario.

For information on reproducing Government of Ontario works, please contact Service Ontario Publications at copyright@ontario.ca

SUMMARY

In 1988, the routine air monitoring program in Ontario included the measurement of nine gases at up to 77 locations and the measurement of particulates at 152 locations.

For gases, the provincial criterion most frequently exceeded was for ozone and was largely associated with medium- and long-range transport of pollution from the United States. Out of 48 ozone stations, 46 measured exceedances of the criterion at least once during the year. Exceedances for sulphur dioxide and total reduced sulphur occurred at some stations as well. The ten-year trends indicate improvement for sulphur dioxide, carbon monoxide and total reduced sulphur, but little change in hydrocarbons, and nitrogen oxides. Ozone, confined to the warm season showed a distinct peak in 1988.

For particulates, the 24-hour criterion for total suspended particulate was frequently exceeded. Out of 152 stations, 119 measured at least one exceedance during the year. Thirty-seven stations had exceedances of the one-year criterion. Five stations measured exceedances of the criterion for lead, and two stations measured exceedances for nickel. No other particulate criteria were exceeded. The ten-year trends show improvement in total suspended particulate as well as in each of the commonly monitored metals: copper and lead. Sulphate and nitrate have been relatively constant over the ten-year period.

The new Air Quality Index system implemented in June 1988 showed that very good to good air quality levels prevailed at all sites across the province (94% of the time or better). There were no incidences of very poor air quality reported at any location. Ozone is by far the most frequent cause of high index readings in Ontario.

The Air Pollution Index, which is still the basis of the alert system for air pollution control in Ontario, had exceedances of the advisory level of 32 at Hamilton and Etobicoke West. At Hamilton the API reached a maximum value of 43 on November 26 while on the same day at Etobicoke West an AQI maximum of 33 was attained.

INTRODUCTION

This report describes the 1988 Ontario air quality monitoring program including a summary of the measurements of gases and particulate matter during the year. It is intended for use in conjunction with an Appendix which appears in a separate volume.

Ambient air quality data are subjected to stringent quality control and quality assurance programs. The Air Resources Branch maintains a reference standards laboratory with air quality standards that are referenced to the U.S. National Bureau of Standards as well as to the Pollution Measurement Division of Environment Canada. Quarterly performance audits on the monitoring equipment and the data acquisition system in the MOE network are carried out to achieve the utmost in data accuracy.

In this report, the following are discussed for each pollutant: characteristics, effects, Ontario criteria (if any), sources, method of monitoring, locations (and frequency) of sampling, summary of sampling results, and ten-year trend.

Also, tables provide the location of stations and the sample distribution information which includes means, maxima and the number of exceedances of the Ontario criteria.

The entire continuous (hourly) network is summarized in Appendix Table A-1 and Maps 1 and 2. This table gives station name, numerical identifier, and an indication of the "continuous" pollutants measured. Letter codes indicate whether data were telemetered or chart-read.

The "continuous" pollutants include SP (suspended particles) as well as the following gases:

- SO₂ (sulphur dioxide)
- CO (carbon monoxide)
- O₃ (ozone)
- NO₂ (nitrogen dioxide)
- NO (nitric oxide)
- NO_x (oxides of nitrogen)
- THC (total hydrocarbons)
- RHC (reactive hydrocarbons)
- TRS (total reduced sulphur)

Section A of this report describes each of the "continuous" pollutants in sequence. Section B deals with the new Air Quality Index system implemented in June, 1988 as well as the ten year history of the the Air Pollution Index.

The particulate (daily) network is summarized in Appendix Table A-3 and Maps 4 and 5. This table provides station name, numerical identifier, and the various "daily" pollutants measured. Also, numerals indicate the monitoring cycle frequency in days. Some additional codes are defined in the key at the top of the table. The main particulate pollutants measured are:

- TSP (total suspended particulate)
- Cd (cadmium)
- Cr (chromium)
- Cu (copper)
- Fe (iron)
- Mn (manganese)
- Ni (nickel)
- Pb (lead)
- V (vanadium)
- NO₃⁻ (nitrate)
- NO₄²⁻ (sulphate)

Section C describes each of the "daily" or particulate pollutants under the headings of TSP, Lead, Trace Metals, Nitrate and Sulphate.

Queries relating to this report or requests for data (magnetic tape or hardcopy) should be addressed to:

Air Quality Assessment and Instrumentation Unit
Air Resources Branch
125 Resources Road
Etobicoke, Ontario
M9W 5L1
Telephone (416) 235-5780
or (416) 235-5778.

GLOSSARY

COH - an estimate of the amount of particulate matter by measuring the amount of light scattering.

Criterion - a desirable maximum ambient air exposure (based on effects).

Exceedance - an occurrence that exceeds the Ontario standard.

Detection limit - the minimum air concentration of a pollutant that can be determined by an analytical method.

Geometric mean - calculated by taking the nth root of the product of all (n) values in a data set.
- provides a better indication than arithmetic mean of central tendency for a small data set with extreme values.

Percentile value - the percentage of the data set that lies below the stated value
- for example, if the 70 percentile value is 0.10 ppm, then 70% of the data are below 0.10 ppm.

Primary pollutant - a pollutant which is directly emitted to the atmosphere.

Secondary pollutant - a pollutant which is formed from other pollutants present in the atmosphere.

"Continuous" - a pollutant for which a continuous record exists; effectively, pollutants which have hourly average data (Maximum 8760 values per year).

"Daily" pollutant - a pollutant for which there exists only a 24 hour or daily value (maximum 365 values per year).

ABBREVIATIONS

- AQC - air quality criterion.
- COH - coefficient of haze.
- ppb - parts (of pollutant) per billion (parts of air).
- ppm - parts (of pollutant) per million (parts of air).
- µg/m³ - micrograms (of pollutant) per cubic metre (of air).

SECTION A POLLUTANTS MEASURED BY CONTINUOUS MONITORING (HOURLY DATA)

SO₂

SULPHUR DIOXIDE

1.1 Characteristics

Colourless gas. Strong, pungent odour over 0.5 ppm.

1.2 Effects

1 hour average

less than .16 ppm - no known effects
0.16 ppm - injurious to

sensitive species of vegetation in combination with ozone.

0.34 ppm

- odourous, increasing vegetation damage

2.00 ppm

- increasing sensitivity of asthmatics and bronchitics

1.3 Ontario Criteria

0.25 ppm (1 hour)
0.10 ppm (24 hours)
0.02 ppm (1 year)

1.4 Sources

80% of the SO₂ emitted in Ontario originates from non-ferrous smelters and electric utilities.

The bulk of the rest comes from other industrial sources including iron ore smelters, petroleum refineries, pulp and paper mills and area sources including vehicles and residential, commercial and industrial heating.

1.5 Method of Monitoring

Fluorescent excitation of SO₂ by ultra-violet radiation.

1.6 Locations of Monitoring

The Appendix provides a description of the provincial SO₂ network (Table A-1)

SO₂ monitoring was carried out at 77 locations in 1988.

1.7 Monitoring Results

The distribution by percentile of the hourly data; the mean; and the maximum one-hour and 24-hour values are provided in the Appendix (Table A-5). Also given are the number of exceedances of the sulphur dioxide criteria (see Section 1.3).

It should be noted that the increase in the annual SO₂ concentrations at some locations in 1988, may be partially artificial due to the implementation of the new telemetry system in June of the same year. Initial evaluation of the new system by the Air Resources Branch, showed that the main difference between the old and new system was due to their difference in the cut off points for rounding off the readings. Since the new telemetry system was shown to be more accurate in its estimations as compared with the old system, the decision was made: 1) to replace the old system with the new system and 2) no attempt will be made to correct the SO₂ data obtained prior to the implementation of the new system.

The lowest annual average levels measured in the province were at Thunder Bay where the hourly SO₂ never exceeded .04 ppm.

The greatest number of exceedances of the one-hour criterion occurred at Copper Cliff in Northeastern Ontario and the highest annual mean was measured at Thorold near an abrasives manufacturer.

There were a total of 17 stations which exceeded the hourly criterion at least once and seven which exceeded the 24-hour criterion. The Thorold station exceeded the annual criterion. (See also Table 1).

1.8 Ten-Year Trend

The trend in mean annual SO₂ at locations which possess a ten-year record is shown in Table A-6 and is summarized for the province in Figure 1.

Mean ambient SO₂ levels improved by about 45% over the ten-year period. This is primarily due to tighter industrial emission controls.

SP

SUSPENDED PARTICLES

2.1 Characteristics

A relative measure of suspended particulate matter of size most likely to reach the lungs (diameter less than 5-10 microns). Determined by the amount of soiling caused by air flow on a filter medium.

2.2 Effects

1 hour average

less than 2.0 COH units - no known effects

2.0 COH units - decrease in visibility

4.0 COH units - soiling evident

6.0 COH units - increasing sensitivity of asthmatics and bronchitics

2.3 Ontario Criteria

1.0 COH units (24 hours)

0.5 COH units (1 year)

2.4 Sources

Industrial processes which include combustion, incineration, construction, mining, metal smelting, processing and grinding. Also motor vehicle exhausts.

Natural sources include wind-blown soil, forest fires, ocean spray, volcanic activity.

2.5 Method of Monitoring

Continuous paper tape sampler with sampling inlet and flow rate regulated to favour small particles.

SP is determined by drawing a known volume of air through a portion of tape and then measuring the reduction in the light transmitted relative to a clean section of tape.

2.6 Locations of Monitoring

The Appendix provides a description of the provincial SP network (Table A-1).

Suspended particles were measured at 47 locations in 1988.

2.7 Monitoring Results

The distribution by percentile of the hourly data; the mean; the maximum one-hour and 24-hour values; and the number of exceedances of the SP criteria (see Section 2.3) are provided in the Appendix (Table A-7).

The lowest levels measured in the province were at Thunder Bay where the SP averaged 0.03 units.

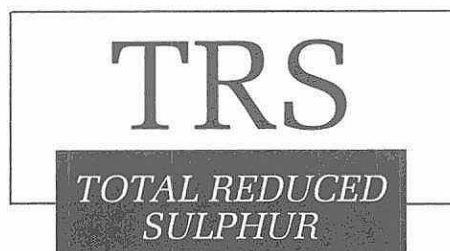
The greatest number of exceedances of the 24-hour criterion occurred at the Mission site (381 Yonge Street) in Toronto and the highest measured value was at Niagara Falls.

There were a total of 27 stations which exceeded the 24-hour criterion at least once and four which exceeded the one year criterion (See also Table 1).

2.8 Ten-Year Trend

The trend in mean annual SP at selected Ontario cities is shown in Table A-8 and is summarized for the province in Figure 1.

Fine particulate, as determined by SP, has remained relatively constant over the past ten years.



3.1 Characteristics

Primarily hydrogen sulphide (rotten egg odour). Also methyl mercaptans (rotten cabbage odour over 5 ppb).

3.2 Effects

1 hour average
less than 5 ppb - no known effects
5 ppb - odour threshold
27 ppb - extremely odorous
1,000 ppb - sensitive individuals may suffer nausea and headache due to severe odour

3.3 Ontario Criteria

Methyl Mercaptans - 10 ppb (1 hour)
Hydrogen Sulphide - 20 ppb (1 hour)
TRS (from Kraft Pulp Mills) - 27 ppb (1 hour)

3.4 Sources

Industrial - steel industry, pulp and paper mills, refineries. Natural - swamps, bogs, marshes.

3.5 Method of Monitoring

Reduced sulphur compounds are oxidized to SO₂ and the SO₂ concentration is measured using fluorescent excitation by ultra-violet radiation.

3.6 Locations of Monitoring

The Appendix provides a description of the provincial TRS network (Table A-1).

TRS monitoring was carried out at 28 locations in 1988.

3.7 Monitoring Results

The distribution by percentile of the hourly data; the mean; and the one-hour and 24-hour maxima are provided in the Appendix (Table A-9).

The lowest average levels measured in the province were at Thunder Bay. The highest annual mean (6.8 ppb) was measured at Cornwall (St. Peters School) and the greatest value measured (268 ppb) occurred at Fort Frances in Northwestern Ontario near a kraft paper mill. (See also Table 1).

3.8 Ten-Year Trend

Table A-10 shows the trend in mean annual TRS for selected Ontario cities while Figure 1 shows the provincial trend, with a minimum in 1985.



4.1 Characteristics

Colourless, odourless.

4.2 Effects

1 hour average
less than 30 ppm - no known effects
30 ppm - increased cardiovascular symptoms on smokers with heart disease
50 ppm - increasing cardiovascular symptoms on non-smokers with heart disease. Some visual impairment.

4.3 Ontario Criteria

30 ppm (1 hour)
13 ppm (8 hours)

4.4 Sources

Primary source (about 80%) is motor vehicles. A secondary source is fossil fuel combustion for building, heating and commercial/industrial operations.

4.5 Method of Monitoring

Non-dispersive infrared photometry based on the preferential absorption of infrared radiation by CO.

4.6 Locations of Monitoring

The Appendix provides a description of the provincial CO network (Table A-1).

CO was monitored at 29 stations in 1988.

4.7 Monitoring Results

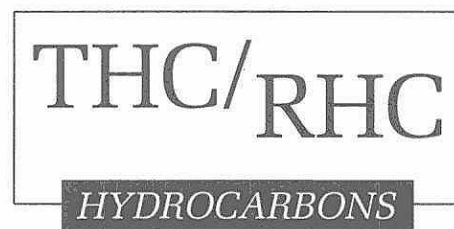
The distribution by percentile of the hourly data; the mean; and the maximum one-hour and eight-hour values are given in the Appendix (Table A-11).

The lowest levels measured in the province were at Sarnia (Centennial Park) and North Bay while the highest mean was at the Mission site (381 Yonge Street) in Toronto. The highest measured one-hour and eight-hour values were also at the Mission site. This monitor is located in the Yonge Street corridor exposing it to motor vehicle exhaust..

There were no exceedances of the Ontario one-hour criterion of 30 ppm. However, the Mission monitor registered 6 exceedances of the eight-hour criterion. (See also Table 1.)

4.8 Ten-Year Trend

There was a 35% decline in ambient CO levels from 1979 to 1983 however, for the past 5 years CO levels have remained constant. (See Figure 1 and Table A-12). This is due primarily to tighter controls on automotive emissions.



5.1 Characteristics

Primarily methane (colourless, odourless) which is present at about 1.5 ppm in the ambient atmosphere. Non-methane hydrocarbons (or reactive hydrocarbons) are usually present at much lower levels. This fraction reacts with nitrogen oxides in the presence of sunlight to form ozone.

5.2 Effects

No known direct effects on health or vegetation at ambient levels.

5.3 Ontario Criteria

None. However, criteria and standards exist for specific hydrocarbons and other organics.

5.4 Sources

Natural sources include trees and other vegetation and decay of animal and plant material.

Anthropogenic sources include motor vehicles, gasoline storage tanks, petroleum and chemical industries, landfill sites, paint manufacture, application and fermentation.

5.5 Method of Monitoring

Calibrated flame ionization detector.

5.6 Locations of Monitoring

The Appendix provides a description of the provincial THC/RHC network (Table A-1).

RHC was monitored at six stations while THC was monitored at 17 locations in 1988.

5.7 Monitoring Results

The distribution by percentile of the hourly data; the mean; and the maximum one-hour and 24-hour values are given in the Appendix (Tables A-13 and A-15).

The locations and values for the lowest, and highest means are given in Table 1. The highest one-hour maximum concentration of reactive hydrocarbon was measured at Nanticoke near a petroleum refinery while the highest 1-hour total hydrocarbon value for the year was measured at Etobicoke (Centennial Park).

5.8 Ten-Year Trend

The trend in the annual average of THC at the 7 stations which have a ten-year record is shown in Table A-14 and is summarized for the province in Figure 2. THC levels have been relatively constant over the ten-year period.

NO₂

NITROGEN DIOXIDE

6.1 Characteristics

Brown gas. Pungent, irritating odour over .10 ppm.

Oxidation product of nitric oxide (NO) which is the primary NO_x emission. Reacts with hydrocarbons in sunlight to form ozone; and with water to form nitric acid, a component of acid rain.

6.2 Effects

1 hour average

less than .10 ppm - no known effects
0.10 ppm - odour threshold
0.25 ppm - some increase in bronchial reactivity in asthmatics

0.52 ppm

- increasing sensitivity of asthmatics and bronchitics

6.3 Ontario Criteria

0.20 ppm (1 hour)

0.10 ppm (24 hours)

6.4 Sources

Anthropogenic - high temperature combustion processes including automobiles, power plants, incinerators and several chemical processes. In Ontario, motorized transportation accounts for about 60% of total NO_x emissions.

Natural - lightning, soil bacteria.

6.5 Method of Monitoring

Based on the principle of chemiluminescence involving a gas phase reaction of NO with ozone. For NO₂, the sample stream is passed through a catalytic converter where NO₂ is reduced to NO.

6.6 Locations of Monitoring

The Appendix provides a description of the provincial NO₂ network (Table A-1).

NO₂ monitoring was carried out at 36 locations in 1988.

6.7 Monitoring Results

The distribution by percentile of the hourly data; the mean; and the maximum one-hour and 24-hour values are provided in the Appendix (Tables A-16). Also given are the number of exceedances of the nitrogen dioxide criteria (see Section 6.3).

The lowest levels measured in the province were at Dorset where the arithmetic mean was 2 ppb.

The highest annual mean (33 ppb) was measured in Etobicoke.

No stations exceeded either the one-hour or 24-hour criterion. (See also Table 1).

6.8 Ten-Year Trend

The ten-year trend in the annual average of NO₂ at selected Ontario cities as shown in Table A-17, and Figure 2 is relatively constant.

NO

NITRIC OXIDE

7.1 Characteristics

Colourless gas. Oxidizes to NO₂ in the

presence of hydrocarbons and sunlight.

7.2 Effects

No known direct effects on health or vegetation at ambient levels.

7.3 Ontario Criteria

None

7.4 Sources

Same as for NO₂.

7.5 Method of Monitoring

Same as for NO₂.

7.6 Locations of Monitoring

Same as for NO₂.

7.7 Monitoring Results

Dorset had the lowest mean and Etobicoke South the highest. (See Appendix Table A-18 for the data summaries.)

7.8 Ten-Year Trend

Figure 2 and Table A-19 show little change in NO over the past ten years.

NO_x

**TOTAL NITROGEN
OXIDES**

8.0

NO_x is assumed to be the sum of NO₂ and NO concentrations in the atmosphere (in parts per million). (See Appendix Table A-20 for the data summaries.)

O₃

OZONE

9.1 Characteristics

Colourless gas. Major component of photochemical oxidant compounds formed as the result of chemical reactions between nitrogen oxides and reactive hydrocarbons in the presence of sunlight.

9.2 Effects

1 hour average

less than 50 ppb	- no known effects
80 ppb	- injurious to many species of vegetation
120 ppb	- decreasing performance by athletes exercising heavily
200 ppb	- decrease in lung function in exercising subjects, eye irritation

9.3 Ontario Criteria

80 ppb (1 hour)

9.4 Sources

Ozone is produced by photochemical reactions and is not directly emitted into the atmosphere in significant amounts. Since it is formed downwind of nitrogen oxide and hydrocarbon sources and capable of travelling long distances through the atmosphere, ozone is a major manifestation of the long range transport of air pollution. Its formation and transport are dependent on meteorological factors. Warm temperatures are critical and elevated concentrations occur from May to

September. Low level (tropospheric) ozone should not be confused with upper level (stratospheric) ozone which gives rise to the naturally occurring "ozone layer". The two layers rarely mix.

9.5 Method of Monitoring

An air sample reacts with ethylene to emit visible light (chemiluminescence) of intensity directly proportional to the ozone concentration. A number of stations still employ fluorescence for ozone detection.

9.6 Locations of Monitoring

The Appendix provides a description of the provincial O₃ network (Table A-1).

Ozone monitoring was carried out at 48 locations in 1988.

9.7 Monitoring Results

The distribution by percentile of the hourly data; the mean; and the maximum one-hour and 24-hour values are provided in the Appendix (Table A-21). Also given are the number of exceedances of the ozone criterion (see Section 9.3).

The lowest levels measured in the province were at the Science Centre in

North York where the arithmetic mean was 9.0 ppb.

The greatest number of exceedances (566) of the one-hour criterion occurred at Long Point Provincial Park and the highest mean concentration (38.3 ppb) for the year was recorded there also.

There were a total of 46 stations which exceeded the criterion at least once. The highest measured concentration was 196 ppb at the CN Tower where the height of the monitor is 444 metres. Concentrations aloft are higher than those at ground level and during the night they are decoupled from the ground by the nocturnal inversion. (See Table 1)

9.8 Ten-Year Trend

Table A-22 provides the ten-year trend for average O₃ at the stations where a ten-year record exists. Figure 2 summarizes the data for the province. The provincial mean has remained relatively constant with the exception of 1988 during which long range transport of pollutants in conjunction with unusual meteorological conditions produced a provincial mean of 24.0 ppb.

TABLE 1 - HIGHLIGHTS OF CONTINUOUS MONITORING 1988

	SO ₂	SP	TRS	CO	THC	NO ₂	NO	O ₃
LOWEST MEAN Location	Thunder Bay (63200)	Thunder Bay (63200)	Thunder Bay (63200)	Sarnia (14064) North Bay (75010)	Nanticoke (22907)	Dorset (49010)	Dorset (49010)	North York (34002)
Concentration	0 ppm	.03 units	0.2 ppb	0.3 ppm	1.61 ppm	.002 ppm	.001 ppm	9.0 ppb
HIGHEST MEAN Location	Thorold (27052)	Toronto (31049)	Cornwall (56071)	Toronto (31049)	Etobicoke (35003)	Etobicoke (35033)	Toronto (31049)	Long Point (22901)
Concentration	.021 ppm	.63 units	6.8 ppb	2.8 ppm	2.27 ppm	.033 ppm	.071 ppm	38.3 ppb
MOST CRITERION EXCEEDANCES-1 HR Location	Copper Cliff (77218)	N/A	Fort Frances (62030)	-	N/A	-	N/A	Long Point (22901)
Number	6	N/A	552*	0	N/A	0	N/A	566
MOST CRITERION EXCEEDANCES-24 HRS Location	Copper Cliff (77218)	Toronto (31049)	N/A	N/A	N/A	-	N/A	N/A
Number	6	26	N/A	N/A	N/A	0	N/A	N/A
NUMBER OF STATIONS EXCEEDING 1-HR AQC Number	17	N/A	18	0	N/A	0	N/A	46
NUMBER OF STATIONS EXCEEDING 24-HR AQC Number	7	27	N/A	N/A	N/A	0	N/A	N/A
HIGHEST MEASURED VALUE-1 HR Location	Copper Cliff (77218)	Niagara Falls (27055)	Fort Frances (62030)	Toronto (31049)	Etobicoke (35003)	Toronto (31104)	Kitchener (26029)	Toronto (31190)
Concentration	1.240 ppm	5.0 units	268 ppb	22 ppm	12.9 ppm	0.200 ppm	.099 ppm	196 ppb
TOTAL NUMBER OF STATIONS Number	77	47	28	29	17	36	36	48

*exceedances of pulp mill criterion

Figure 1
10-Year Trend in Continuous Pollutants SO₂, SP, CO, TRS

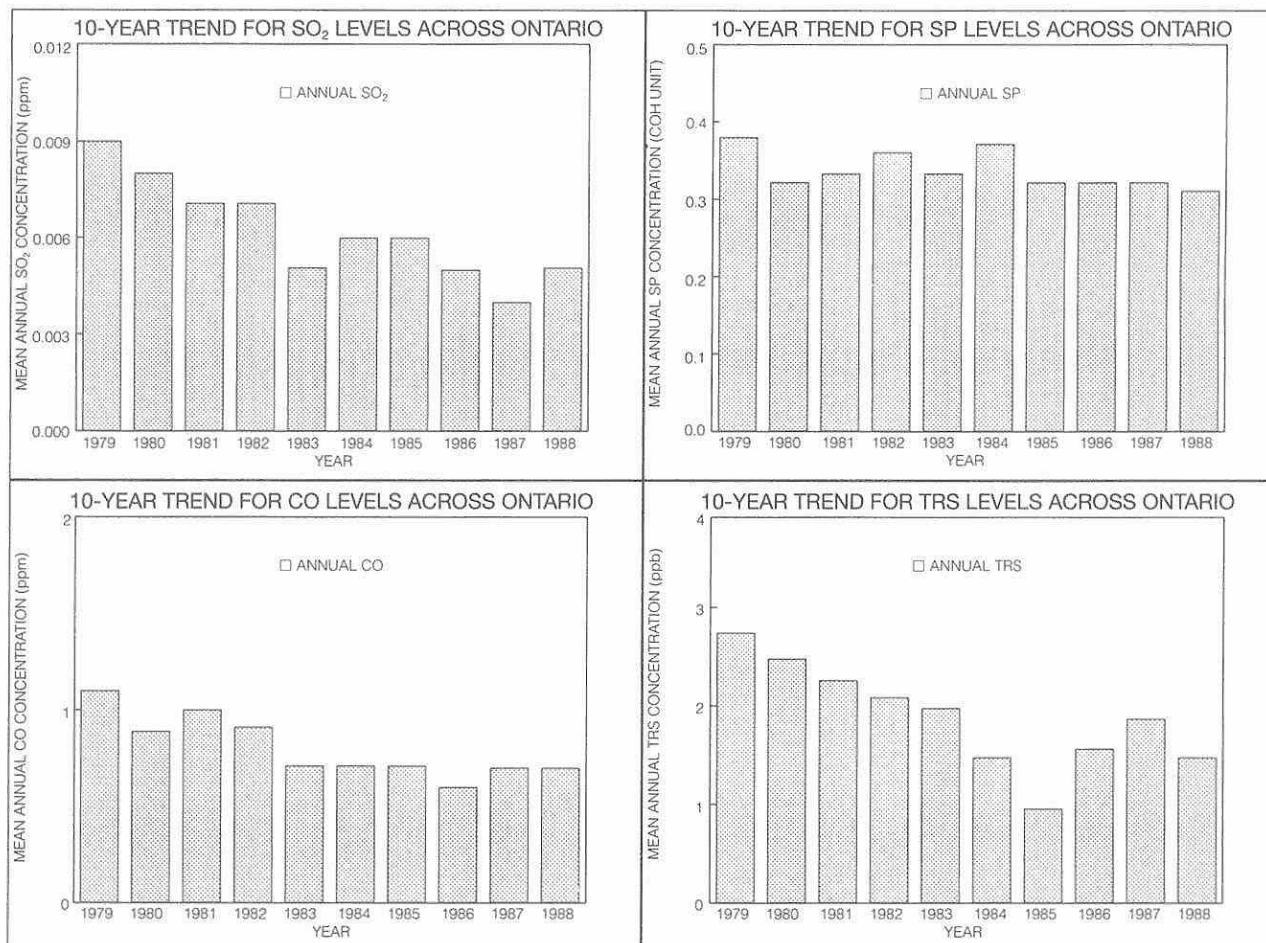
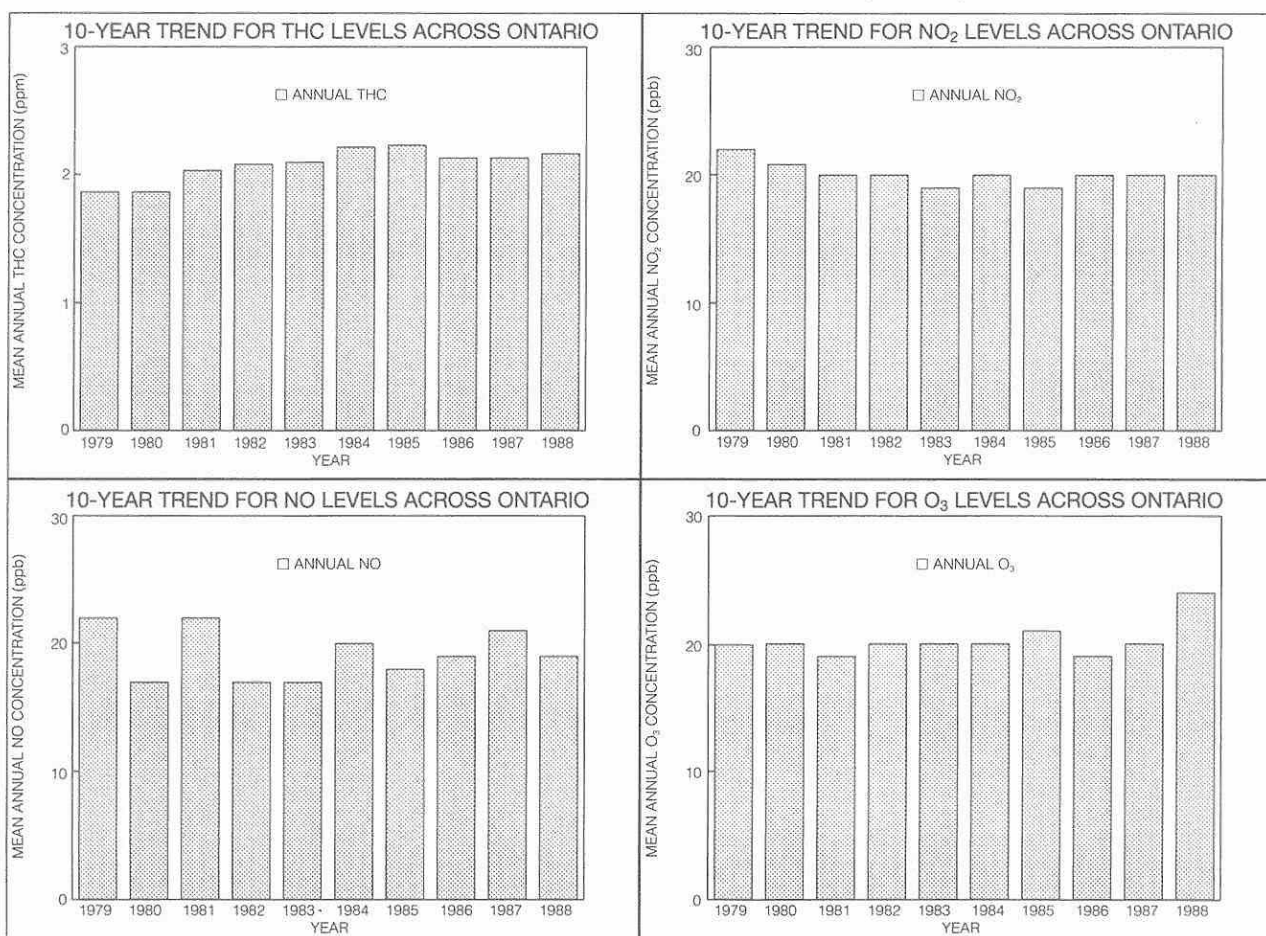


Figure 2
10-Year Trend in Continuous Pollutants THC, NO₂, NO, O₃



SECTION B

THE ONTARIO AIR QUALITY INDEX

10.1 Characteristics

The Air Quality Index (AQI) is a real-time information system that provides the public with an indication of air quality in 26 major cities across Ontario. The system has been in operation since June 1988. The AQI is derived from the sub-indices which are calculated for the pollutants that have evidence of adverse effects on the environment. These pollutants are sulphur dioxide, ozone, nitrogen dioxide, total reduced sulphur, carbon monoxide and suspended particles. In addition, the API (Section 11.0) is also included as one of the AQI sub-indices. The AQI is provided to the public eight times daily and it is increased to hourly releases when the index reaches 32; the level at which air quality is deemed moderate.

10.2 Effect

The AQI sub-index is calculated on a hourly basis for each pollutant. The sub-index increases as the air quality deteriorates. The index values, the corresponding categories and the health and environmental effects are given in Table 2. The highest sub-index at the given time becomes the AQI.

If the index value reaches 50 - 99, the air quality may have adverse effect on the sensitive human population or animal, or may cause significant damage to vegetation, property, or aesthetic value. An AQI value of 100 or greater will cause adverse effect to the health of a large sector of the exposed population.

10.3 Operation of the System

There are 33 AQI monitoring sites in Ontario. The larger cities have more than one AQI station (See Map 3 in Appendix). The cities are selected according to population and previous air quality history. The data from the 33 AQI stations are accessed on a real-time basis by the computer center at the Air Resources Branch. The computed AQIs are released to the public, and the news media 8 times daily. In addition, AQI forecasts based on the

meteorological conditions are issued four times daily. In the event that one of the AQI stations has an index greater than 31, the AQI information will be released hourly until it drops below 32.

10.4 Air Quality Index Levels (June - December 1988)

Frequency distribution of the hourly AQI according to descriptive category, and according to the pollutant responsible for $AQI \geq 32$ is shown for the thirty-three monitoring locations across Ontario in Table 3. In general, good to very good air quality levels prevailed at all sites throughout the province (94% of the time or better). There were no occurrences of Very Poor air quality reported at any locations. Also evident from the table, ozone is by far the most frequent cause of high index readings in Ontario.

11.0 Air Pollution Index

11.1 Characteristics

The API continues to be the basis of an alert and control system to warn of deteriorating air quality and is derived from 24-hour running averages of sulphur dioxide and suspended particles. Research studies have linked respiratory illness to high concentrations of sulphur dioxide and particulates.

11.2 Legislation

The Ontario Environmental Protection Act (1971) authorizes the Minister of the Environment to order any source not essential to public health or safety to curtail or cease its operations when air pollution levels which may be injurious to health occur.

11.3 Operation of the System

The API is computed each hour based on the past 24 hourly values for SO_2 and SP. If the index reaches a value of 32 (as for example when $SO_2 = 0.1$ ppm and $SP = 1.0$) and if the Duty Meteorologist predicts a continuation of adverse atmospheric conditions for at least six hours, an Air Pollution Advisory is issued. Owners of significant sources of pollution are advised to prepare for possible curtailment of operations.

If the index reaches 50, and if at least six hours of adverse atmospheric

conditions are forecast, owners of major sources may be ordered to curtail operations. This is called the First Alert Level.

A Second Alert is issued at an API of 75, and further curtailment may be ordered.

The Air Pollution Episode Threshold Level occurs at an API of 100. If atmospheric conditions are not expected to improve for at least six hours, owners of all sources not essential to public health or safety may be ordered to cease operations.

11.4 Air Pollution Index Levels (1979 - 1988)

A history of the Air Pollution Index levels over the last ten years of its operation is provided in Table 4.

TABLE 2 - AIR QUALITY INDEX POLLUTANTS AND THEIR IMPACT

INDEX	CATEGORY	CARBON MONOXIDE CO	NITROGEN DIOXIDE NO ₂	OZONE O ₃	SULPHUR DIOXIDE SO ₂	SUSPENDED PARTICLES SP	SO ₂ +SP (AS MEASURED BY THE API	TOTAL REDUCED SULPHUR TRS
100- over	Very poor	Increasing cardiovascular symptoms in non smokers with heart disease some visual impairment	Increasing sensitivity of patients with asthma and bronchitis	Light exercise produces respiratory effects in patients with chronic pulmonary disease	Increasing sensitivity in patients with asthma and bronchitis	Increasing sensitivity in patients with asthma and bronchitis	Significant respiratory effects in patients with asthma and bronchitis	Sensitive Individuals may suffer nausea and headaches due to severe odour
50-99	Poor	Increasing cardiovascular symptoms in smokers with heart disease	Odour and discoloration. Some increase in bronchial reactivity in asthmatics	Decreasing performance by athletes exercising heavily	Odorous increasing vegetation damage	Visibility decreased soiling evident	Increased symptoms in patients with chronic respiratory disease	Extremely odorous
32-49	Moderate	Blood chemistry but no detectable impairment	Odorous	Injurious to many vegetation species eg. white beans tomatoes, etc.	Injurious to some species of vegetation	Some decrease in visibility	Injurious to vegetation due to sulphur dioxide	Odorous
16-31	Good	No effects	Slight odour	Injurious to some vegetation species in combination with SO ₂ (4 hrs)	Injurious to some vegetation species in combination with ozone (4 hrs)	No effects	No effects	Slight odours
0-15	Very good	No effects	No effects	No effects	No effects	No effects	No effects	No effects

TABLE 3 - AIR QUALITY INDEX SUMMARY - JUNE TO DECEMBER 1988

STATION ID	CITY NAME	Number of Hours AQI in Range					Number of Hours Pollutant Responsible for AQI≥32						
		V. GOOD 0-15	GOOD 16-31	MODERATE 32-50	POOR 51-99	V. POOR 100+	SO ₂	SP	O ₃	TRS	CO	API	NO ₂
44008	BURLINGTON	3968	1102	63	3	0	0	35	31	-	0	0	0
56051	CORNWALL	4331	612	167	26	0	0	8	66	119	0	0	0
32010	EAST YORK	4381	586	55	0	0	0	28	27	-	0	0	0
35003	ETOBICOKE-NORTH	3323	1157	228	8	0	0	90	137	-	0	13	0
35033	ETOBICOKE-SOUTH	3830	1196	106	4	0	0	49	53	-	0	0	0
28028	GUELPH	4588	419	107	0	0	0	0	107	-	0	0	0
29000	HAMILTON-DOWNTOWN	3864	1041	238	10	0	0	65	138	5	0	40	0
29105	HAMILTON-EAST	4460	529	109	2	0	0	12	99	-	0	0	0
29114	HAMILTON-MOUNTAIN	4412	548	142	5	0	0	0	135	12	0	0	0
29118	HAMILTON-WEST	3999	901	186	6	0	0	28	164	-	0	0	0
26029	KITCHENER	4215	705	207	2	0	0	62	147	-	0	0	0
52020	KINGSTON	4902	133	80	5	0	0	0	85	-	0	0	0
15001	LONDON	4268	708	153	7	0	0	5	155	-	0	0	0
46110	MISSISSAUGA	4472	534	124	6	0	0	22	108	-	0	0	0
27056	NIAGARA FALLS	4140	770	194	12	0	0	0	206	-	0	0	0
34020	NORTH YORK-CENTRAL	4224	755	143	14	0	0	7	150	-	0	0	0
34025	NORTH YORK-WEST	4449	586	97	1	0	0	14	84	-	0	0	0
75010	NORTH BAY	4392	526	102	0	0	0	0	102	-	0	0	0
44015	OAKVILLE	4132	858	136	10	0	0	24	119	3	0	0	0
45025	OSHAWA	4320	684	126	6	0	0	13	120	-	0	0	0
51001	OTTAWA	4642	432	57	4	0	0	5	56	-	0	0	0
14064	SARNIA	4406	624	104	2	0	0	4	101	1	0	0	0
71068	SAULT-STE-MARIE	4603	443	37	0	0	0	13	12	12	0	0	0
33003	SCARBOROUGH	4284	745	102	5	0	0	11	96	-	0	0	0
27067	ST CATHARINES	4415	606	108	7	0	0	2	113	-	0	0	0
77203	SUDBURY	4430	585	83	12	0	17	0	78	0	0	0	0
63200	THUNDER BAY	4999	136	1	0	0	0	0	0	1	0	0	0
31104	TORONTO-DOWNTOWN	4407	625	98	6	0	0	4	100	-	0	0	0
31120	TORONTO-WEST	4484	502	127	7	0	0	24	110	-	0	0	0
26045	WATERLOO	4620	427	61	1	0	0	0	62	-	0	0	0
12008	WINDSOR-UNIVERSITY	3340	1560	216	17	0	0	46	187	-	0	0	0
12016	WINDSOR-COLLEGE	3877	967	289	21	0	0	19	206	85	0	0	0
36030	YORK	4003	931	190	12	0	0	58	144	-	0	0	0

TABLE 4
TEN-YEAR HISTORY OF THE AIR POLLUTION INDEX (1979-1988)

YEAR	CITY	NUMBER OCCASIONS		MAXIMUM INDEX	DATE OF MAXIMUM
		≥32	≥50		
1979	TORONTO	2	0	35	Oct. 18
	HAMILTON	23	1	55	Dec. 22
	SUDBURY	0	0	18	July 7
	WINDSOR (12008)	0	0	31	Feb. 20
	WINDSOR (12016)	0	0	27	Feb. 21
	NIAGARA FALLS	0	0	27	Feb. 21
	CONISTON	0	0	31	Feb. 14
	NEW SUDBURY	0	0	28	Feb. 14
	SARNIA	2	0	43	Feb. 20
	ST. CATHARINES	0	0	29	Nov. 6
1980	TORONTO	0	0	31	Dec. 8
	HAMILTON	5	0	40	Oct. 16
	SUDBURY	0	0	23	Oct. 16
	WINDSOR (12008)	0	0	25	Feb. 8, 9
	WINDSOR (12016)	0	0	25	Dec. 29
	NIAGARA FALLS	0	0	18	May 24
	CONISTON	0	0	30	Feb. 10, Mar. 9
	NEW SUDBURY	0	0	24	Jul. 3, Oct. 16
	SARNIA	1	0	39	Mar. 20
	ST. CATHARINES	0	0	28	Feb. 20
1981	TORONTO	3	0	43	Nov. 14
	HAMILTON	8	0	38	Nov. 15
	SUDBURY	0	0	21	Jan. 31
	WINDSOR (12008)	1	0	42	Nov. 17
	WINDSOR (12016)	0	0	31	Nov. 17
	NIAGARA FALLS	0	0	25	Jan. 14
	CONISTON	0	0	20	Nov. 25
	NEW SUDBURY	0	0	22	Jan. 28-29
	SARNIA	1	0	34	Feb. 16
	ST. CATHARINES	0	0	27	Jan. 14-15
1982	TORONTO	3	2	54	Oct. 27
	HAMILTON	12	0	39	Dec. 2
	SUDBURY	0	0	15	Feb. 3
	WINDSOR (12008)	0	0	31	Oct. 26-27
	WINDSOR (12016)	1	0	35	Oct. 27
	NIAGARA FALLS	0	0	19	Jan. 19
	CONISTON	1	0	39	Feb. 5
	NEW SUDBURY	0	0	29	Feb. 5
	SARNIA	0	0	27	Mar. 11, Nov. 7-8
	ST. CATHARINES	0	0	31	Nov. 18
1983	TORONTO	3	0	39	Jan. 29
	HAMILTON	1	0	37	Mar. 2
	SUDBURY	1	0	39	Jan. 22
	WINDSOR (12008)	0	0	26	Sep. 27
	WINDSOR (12016)	1	0	33	Mar. 1-2
	NIAGARA FALLS	0	0	17	Jan. 30
	CONISTON	0	0	19	Jan. 15
	NEW SUDBURY	1	1	63	Jan. 22
	SARNIA	0	0	28	Jan. 29
	ST. CATHARINES	0	0	23	Jan. 30
1984	TORONTO	2	1	50	Jan. 16
	HAMILTON	8	0	44	Nov. 27
	SUDBURY	0	0	23	Feb. 1
	WINDSOR (12008)	0	0	31	Oct. 2, Nov. 14
	WINDSOR (12016)	1	0	40	Feb. 15
	NIAGARA FALLS	0	0	20	Dec. 10-11
	CONISTON	0	0	29	Nov. 22
	NEW SUDBURY	0	0	23	Nov. 22
	SARNIA	0	0	27	Jan. 23
	ST. CATHARINES	0	0	24	Feb. 10-11

TABLE 4 (CONT.)
TEN-YEAR HISTORY OF THE AIR POLLUTION INDEX (1979-1988)

YEAR	CITY	NUMBER OCCASIONS		MAXIMUM INDEX	DATE OF MAXIMUM
		≥32	≥50		
1985	TORONTO	0	0	25	Apr. 23
	HAMILTON	2	0	36	Apr. 23-24
	SUDBURY	0	0	31	Aug. 4
	WINDSOR (12008)	0	0	25	Dec. 20
	WINDSOR (12016)	0	0	30	Dec. 20
	NIAGARA FALLS	0	0	19	Apr. 24
	CONISTON	0	0	19	Mar. 26
	NEW SUDBURY	0	0	31	Jan. 7
	SARNIA	0	0	20	Mar. 27-28
	ST. CATHARINES	0	0	18	Dec. 6
1986	TORONTO	0	0	22	Jan. 17
	HAMILTON	5	0	37	May 15
	SUDBURY	0	0	23	Oct. 26
	WINDSOR (12008)	0	0	31	Jan. 16, Oct. 22, 7 Dec. 16
	WINDSOR (12016)	0	0	29	Mar. 14
	NIAGARA FALLS	0	0	17	Jan. 17
	CONISTON	0	0	18	Mar. 20-21
	NEW SUDBURY	0	0	20	Apr. 23
	SARNIA	0	0	29	Dec. 17
	ST. CATHARINES	0	0	18	Jan. 17
1987	TORONTO	0	0	31	Oct. 16
	HAMILTON	2	0	38	Oct. 17
	SUDBURY	0	0	26	Mar. 14
	WINDSOR (12008)	0	0	24	Apr. 10
	WINDSOR (12016)	0	0	20	Jun. 25; Oct. 24
	NIAGARA FALLS	0	0	16	Oct. 16-17
	CONISTON	0	0	23	Mar. 9; Mar. 11
	NEW SUDBURY	0	0	22	Mar. 11; Mar. 14; 7 Aug. 27
	SARNIA	0	0	24	Jan. 28
	ST. CATHARINES	0	0	24	Oct. 16-17
1988	TORONTO DOWNTOWN	0	0	22	Jul. 7
	HAMILTON DOWNTOWN	1	0	43	Nov. 25-26
	SUDBURY	0	0	25	Jun. 17-18
	WINDSOR (12008)	0	0	28	Nov. 23; Dec. 7
	WINDSOR (12016)	0	0	24	Jan. 8-9
	NIAGARA FALLS	0	0	20	Nov. 26
	& CONISTON	0	0	21	Apr. 19
	& NEW SUDBURY	0	0	21	Jun. 15
	SARNIA	0	0	26	Jan. 30
	ST. CATHARINES	0	0	24	Jul. 21
	* TORONTO WEST	0	0	13	Dec. 13
	* EAST YORK	0	0	22	Nov. 4
	* SCARBOROUGH	0	0	29	Sep. 30
	* NORTH YORK CENTRAL	0	0	23	Nov. 26
	* NORTH YORK WEST	0	0	27	Nov. 26
	* ETOBICOKE WEST	1	0	33	Nov. 26
	* ETOBICOKE SOUTH	0	0	29	Nov. 26
	* YORK	0	0	29	Nov. 26
	* BURLINGTON	0	0	27	Sep. 8-9
	* OAKVILLE	0	0	24	Sep. 2
	* OSHAWA	0	0	23	Jun. 15; Jul. 7
	* MISSISSAUGA	0	0	18	Jul. 19; Aug. 5
	* LONDON	0	0	22	Nov. 26
	* KITCHENER	0	0	26	Aug. 2
	* WATERLOO	0	0	17	Nov. 25-26
	* GUELPH	0	0	18	Nov. 26
	* HAMILTON EAST	0	0	20	Nov. 26
	* HAMILTON MOUNTAIN	0	0	23	Nov. 26
	* HAMILTON WEST	0	0	26	Nov. 25-26
	* SAULT STE MARIE	0	0	24	Jun. 20
	* NORTH BAY	0	0	16	Nov. 26
	* OTTAWA	0	0	18	Aug. 5; Dec. 19-20
	* CORNWALL	0	0	20	Jun. 7
	* THUNDER BAY	0	0	5	Nov. 24-25

* started June, 1988
& closed May, 1988

SECTION C POLLUTANTS MEASURED BY HIGH VOLUME SAMPLER MONITORING (DAILY DATA)

TSP

TOTAL SUSPENDED PARTICULATE

11.1 Characteristics

Total suspended particulate is a generic term for airborne particles including smoke, fume, dust, fly ash and pollen. Composition varies with place and season but normally includes soil particulates, organic matter, sulphur and nitrogen compounds and metals such as lead. Size range is approximately .1 to 100 microns (diameter).

11.2 Effects

The greatest impact on health is from particles less than 10 microns in diameter which can penetrate deep into the lungs and contribute to respiratory disease. More serious health effects may be associated with suspended particulate matter which contains a toxic particulate component or which has absorbed a gaseous pollutant on the surface of the particles. Corrosion, soiling, damage to vegetation and visibility reduction are additional effects.

11.3 Ontario Criteria

120 $\mu\text{g}/\text{m}^3$ (24 hours)
60 $\mu\text{g}/\text{m}^3$ (1 year - geometric mean)

11.4 Sources

Natural sources include wind-blown soil, forest fires and plant pollen. Anthropogenic sources include combustion, incineration, construction, mining, metals smelting and processing, grinding processes, agricultural activity and transportation.

11.5 Method of Monitoring

By High Volume Sampler. Air is drawn through a filter at the rate of approxi-

mately 1.4 m^3/min . The (daily) mass concentration of total suspended particulate matter is computed from the mass of collected particles and the volume of air sampled.

11.6 Location and Frequency of Monitoring

The monitoring locations and the frequency of sampling at each location are indicated in the Appendix (Table A-3).

TSP was measured at 152 locations in 1988.

11.7 Monitoring Results

The distribution by percentile; the maximum; the arithmetic and geometric means are given in the Appendix (Table A-23). Also given are the number of exceedances of the 24-hour and one-year criteria.

11.7 Monitoring Results (cont'd)

The lowest levels measured in the province were at Dorset where the annual mean was 11 $\mu\text{g}/\text{m}^3$.

The greatest percentage of exceedances of the 24-hour criterion occurred at Thorold and the highest annual mean was measured there also.

There were a total of 119 stations which exceeded the 24-hour criterion and 37 which exceeded the one-year criterion. (See also Table 5.)

11.8 Ten-Year Trend

The trend in mean annual TSP at locations which possess a ten-year record is shown in Table A-24 and is summarized for the province in Figure 3. Particulate levels have improved since 1979 by about 25%.

Pb

LEAD IN SUSPENDED PARTICULATE

12.1 Characteristics

A silver bluish, white, soft metal. Molecular weight 207.20.

12.2 Effects

Can degrade renal function, impair hemoglobin synthesis, and alter the nervous system.

12.3 Ontario Criteria

5.0 $\mu\text{g}/\text{m}^3$ (24 hours)
2.0 $\mu\text{g}/\text{m}^3$ (30 day - geometric mean)

12.4 Sources

Combustion of gasoline containing lead additives, secondary smelting of lead, battery manufacture, metal fabrication, some paint and glass manufacture, production of iron, steel, copper and nickel.

Lead emissions fell significantly after 1975 with the introduction of lead-free gasoline.

12.5 Method of Monitoring

Lead concentration on high volume filters determined by either X-Ray fluorescence or atomic absorption.

12.6 Location and Frequency of Monitoring

The monitoring locations and sampling frequency for each location are indicated in the Appendix (Table A-3).

Lead was measured at 79 locations in 1988.

12.7 Monitoring Results

The distribution by percentile; the maximum; the arithmetic and geometric means are given in the Appendix (Table A-25). Also given are the number of exceedances of the 24-hour criterion.

The greatest percentage of exceedances of the 24-hour criterion occurred at Mississauga (2414 Dixie Road) in the vicinity of a lead processing plant. The highest annual mean and the highest measured value also occurred there.

There were a total of five stations which exceeded the daily criterion at least once. (See also Table 5.)

12.8 Ten-Year Trend

Lead levels in air have improved very significantly over the past ten years (see Figure 3).

The trend at selected Ontario cities is shown in Table A-26; the decline is largely due to the decreased use of leaded gasoline.

TRACE METALS

**CADMIUM,
CHROMIUM, COPPER,
IRON, MANGANESE,
NICKEL, VANADIUM**

13.1 Characteristics

Name	Symbol	Properties	Molecular Weight
Cadmium	Cd	silver white, hexagonal	112.41
Chromium	Cr	steel grey, cubic	52.00
Copper	Cu	red, cubic	63.55
Iron	Fe	silver, cubic	58.85
Manganese	Mn	grey-pink, cubic	54.94
Nickel	Ni	silver, cubic	58.60
Vanadium	V	light grey, cubic	50.94

13.2 Effects

Depth of penetration into the respiratory system (and consequently risk to health) increase as particle size decreases. Of the heavy metals, cadmium, chromium and vanadium probably pose the greatest risk to human health. Soiling and damage to vegetation are additional effects.

13.3 Ontario Criteria

	24 Hour Criterion
Cadmium	2 $\mu\text{g}/\text{m}^3$
Chromium	1.5 $\mu\text{g}/\text{m}^3$
Copper	50 $\mu\text{g}/\text{m}^3$
Manganese	10 $\mu\text{g}/\text{m}^3$
Nickel	2 $\mu\text{g}/\text{m}^3$
Vanadium	2 $\mu\text{g}/\text{m}^3$

13.4 Sources

See Section 1.4.

13.5 Method of Monitoring

Collection is by High Volume Sampler (see Section 11.5). Following determination of TSP, a portion is cut from the exposed filter and ashed to destroy carbonaceous matter. The ashed sample is then digested in acid, and analyzed by atomic absorption spectrophotometry. The mass concentration of each metal in ambient air is calculated from the mass of each metal in

TSP and the volume of air sampled, and expressed in $\mu\text{g}/\text{m}^3$.

13.6 Location and Frequency of Sampling

The monitoring locations and the sampling frequency for each location are indicated in the Appendix (Table A-3).

Metals were measured at 52 to 58 stations depending on the element.

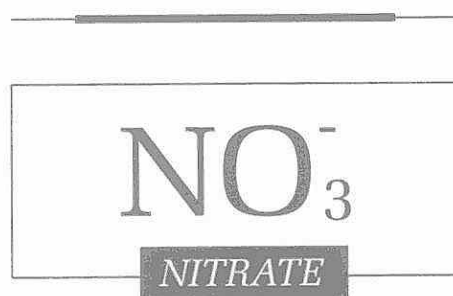
13.7 Monitoring Results

The distribution by percentile of the daily data; the maximum; the arithmetic mean; the geometric mean; and the number of exceedances of the daily criterion are provided in the Appendix for Copper, Iron, Manganese, Nickel, Chromium, Cadmium and Vanadium. Table A-36 shows the maximum monitored levels for all the trace metals listed above.

Table 5 provides the highlights of Particulate Monitoring for 1988. It shows that three exceedances of the air quality criteria for metals (exclusive of lead) occurred in 1988. Two exceedances occurred at Copper Cliff and the other exceedance occurred at Port Colborne. The metal responsible was nickel. Such exceedances may be harmful to vegetation.

13.8 Ten-Year Trend

The trend in mean annual Copper and Iron is shown in Tables A-28 and A-30, respectively, and is summarized for Ontario in Figure 3. Copper has declined by 60% while Iron has remained relatively constant over the past ten years.



14.1 Characteristics

Nitrogen oxide compounds, formed from atmospheric nitrogen and oxygen through high temperature combustion, photochemical reactions or bacterial action, may react with other compounds in the air to form nitrate (NO_3^-) or nitric acid (HNO_3).

14.2 Effects

Nitrate and nitric acid are involved in corrosion of materials, visibility degradation and acidic precipitation. They may also have an adverse effect on human health.

14.3 Ontario Criteria

None

14.4 Sources

Nitrate is primarily a secondary pollutant. Anthropogenic sources of nitrogen oxides or nitrates include all high temperature combustion processes, transportation, and fertilizer production and usage. Natural sources include lightning, biological decomposition and photochemical reactions.

14.5 Method of Monitoring

Nitrates collected on glass fibre filters by a High Volume Sampler are extracted by digestion in distilled water. This extract is reduced to nitrite followed by colourimetric analysis for determination of the mass concentration of atmospheric nitrate.

14.6 Location and Frequency of Monitoring

The monitoring locations and the length of the sampling cycle (in days) for each location are indicated in the Appendix (Table A-3).

Nitrate monitoring was carried out at 58 locations in 1988.

14.7 Monitoring Results

The distribution by percentile; the maximum; the arithmetic mean; and the geometric mean are given in the Appendix (Table A-37). Highlights of monitoring are summarized in Table 5.

The highest annual mean nitrate concentration occurred at Windsor (City Hall) and the highest concentration for a single day occurred at the Windsor (University Avenue) monitor.

14.8 Ten-Year Trend

The trend in mean annual NO_3^- at locations which possess a ten-year record is shown in Table A-38 and is summarized for the province in Figure 4.

Since nitrate is primarily the result of medium and long range transport of air pollution, its variability is largely related to meteorological variability.



SULPHATE

15.1 Characteristics

Sulphur dioxide is oxidized in the atmosphere to eventually form sulphate compounds. Intermediaries in the oxidation process such as HSO_3 and SO_3 rapidly combine with water vapour to form sulfuric acid aerosol. This type of process is dependent on atmospheric conditions.

15.2 Effects

Sulphate compounds have been linked to respiratory irritation and disease, corrosion of materials, reduction of visibility and the formation of acidic precipitation.

15.3 Ontario Criteria

None.

15.4 Sources

Sulphate is primarily a secondary pollutant. Anthropogenic sources of sulphur oxides include the burning of fuels containing sulphur (such as coal and oil), the smelting of sulphur-containing ores and the refining of petroleum. Natural sources include bacterial decomposition, volcanoes and forest fires.

15.5 Method of Monitoring

Sulphate collected on glass fibre filters by a High Volume Sampler is extracted by digestion in distilled water. This extract is analyzed colourimetrically and the mass concentration of sulphate is calculated. It has been found that artifact sulphates form on the glass fibre filters from ambient SO_2 and that reported sulphate concentrations are therefore artificially high. No attempt has been made to correct the data reported here.

15.6 Location and Frequency of Monitoring

The monitoring locations and the

length of the sampling cycle (in days) for each location are indicated in the Appendix (Table A-3).

Sulphate monitoring was carried out at 58 locations in 1988.

15.7 Monitoring Results

The distribution by percentile; the maximum; the arithmetic mean; and the geometric mean are given in the Appendix (Table A-39). Highlights of monitoring are summarized in Table 5.

The highest annual mean sulphate concentration was measured at Hamilton (Vickers/East 18th), and the highest concentration for a single day occurred at Oshawa.

15.8 Ten-Year Trend

The variability of the annual means for sulphate (see Figure 4 and Table A-40) may be explained by meteorological variability as in the case of nitrate (Section 14.8).

TABLE 5- HIGHLIGHTS OF PARTICULATE MONITORING 1988

	TSP	Pb	Cu	Fe	Mn	Ni	NO_3^-	SO_4^{2-}
LOWEST MEAN Location	Dorset (49010)	Several	Several	Several	Mooretown (14031)	Several	Sudbury (77016) (77026)	Thunder Bay (63005)
Concentration	11 $\mu\text{g}/\text{m}^3$	0.1 $\mu\text{g}/\text{m}^3$	0.01 $\mu\text{g}/\text{m}^3$	0.3 $\mu\text{g}/\text{m}^3$.011 $\mu\text{g}/\text{m}^3$.005 $\mu\text{g}/\text{m}^3$	0.8 $\mu\text{g}/\text{m}^3$	3.2 $\mu\text{g}/\text{m}^3$
HIGHEST GEOM MEAN Location	Thorold (27052)	Mississauga (46041)	Sudbury (77016)	Hamilton (29011)	Hamilton (29011)	Copper Cliff (77070)	Windsor (12002)	Hamilton (29114)
Concentration	114 $\mu\text{g}/\text{m}^3$	2.0 $\mu\text{g}/\text{m}^3$	0.23 $\mu\text{g}/\text{m}^3$	5.4 $\mu\text{g}/\text{m}^3$.377 $\mu\text{g}/\text{m}^3$.193 $\mu\text{g}/\text{m}^3$	4.1 $\mu\text{g}/\text{m}^3$	11.3 $\mu\text{g}/\text{m}^3$
PERCENTAGE OF SAMPLES ABOVE 24-HR AQC Location	Thorold (27052)	Mississauga (46041)				Copper Cliff (77070)		
Number	45	19	0	N/A	0	1	N/A	N/A
NUMBER OF STATIONS EXCEEDING 24-HR AQC Number	119	5	0	N/A	0	2	N/A	N/A
NUMBER OF STATIONS EXCEEDING 1 YR AQC Number	37	N/A	N/A	N/A	N/A	N/A	N/A	N/A
HIGHEST MEASURED VALUE-24 HRS Location	Hearst (72080)	Mississauga (46041)	Copper Cliff (77070)	S.S. Marie (71042)	Hamilton (29025)	Copper Cliff (77070)	Windsor (12008)	Oshawa (45025)
Concentration	710 $\mu\text{g}/\text{m}^3$	34.3 $\mu\text{g}/\text{m}^3$	1.62 $\mu\text{g}/\text{m}^3$	64.7 $\mu\text{g}/\text{m}^3$	3.830 $\mu\text{g}/\text{m}^3$	6.140 $\mu\text{g}/\text{m}^3$	18.1 $\mu\text{g}/\text{m}^3$	50.9 $\mu\text{g}/\text{m}^3$
TOTAL NUMBER OF STATIONS Number	152	79	52	56	53	53	58	58

Figure 3
10-Year Trend in Particulate Pollutants TSP, Pb, Cu, Fe

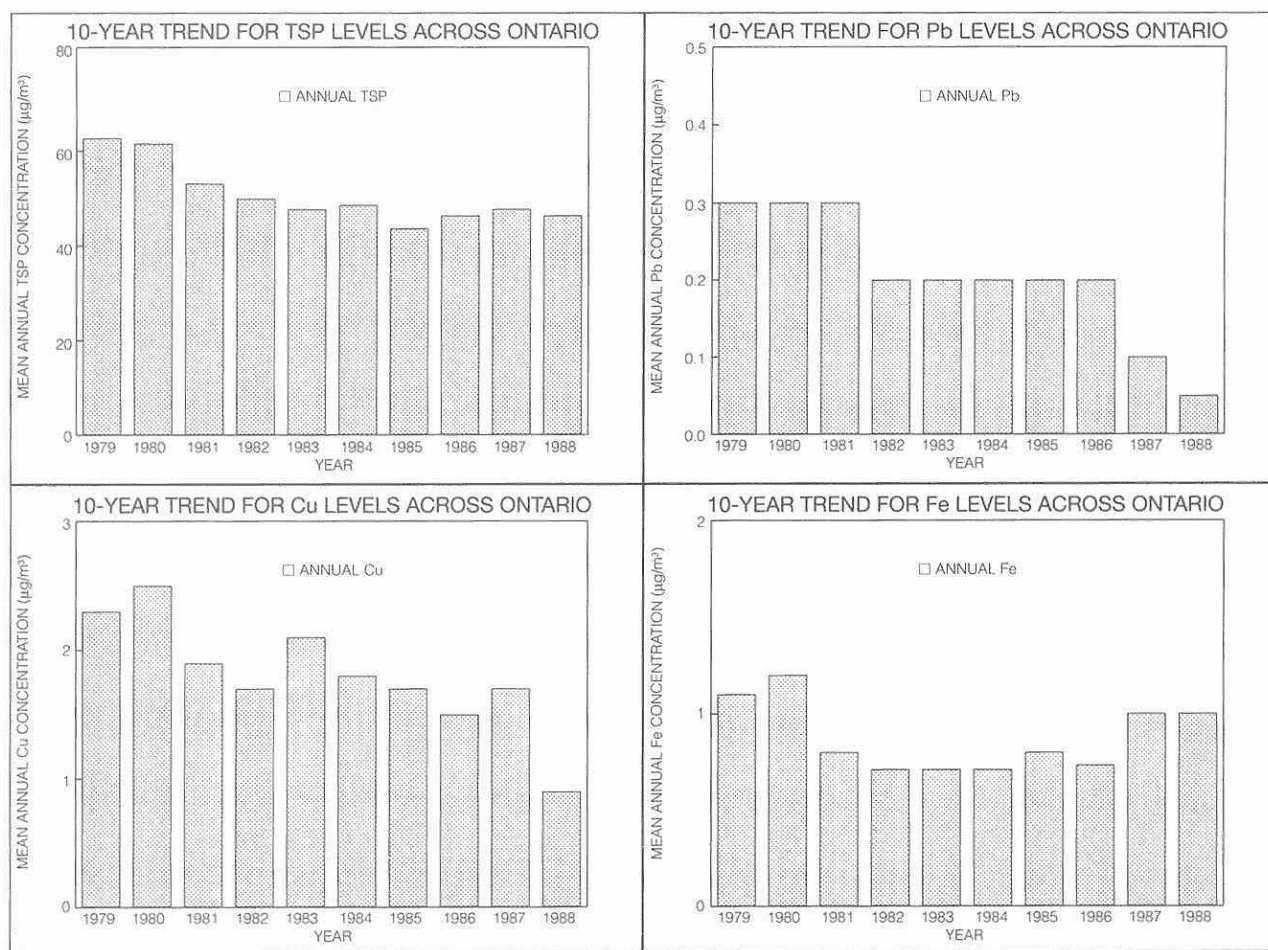
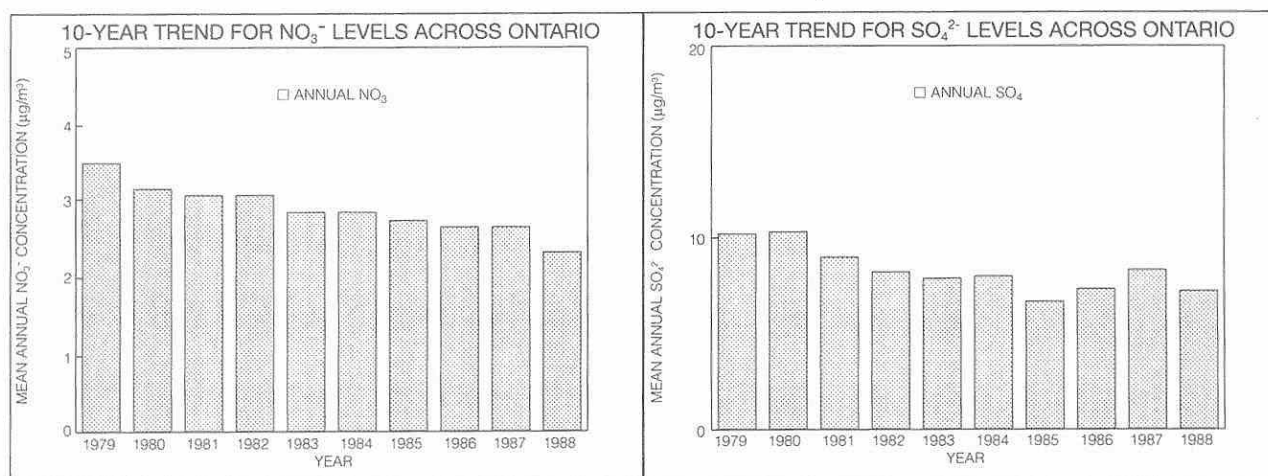


Figure 4
10-Year Trend in Particulate Pollutants NO_3^- and SO_4^{2-}



TD
883.7
.C3
O5
A5

Air quality in Ontario 1988 : a
review of the air quality
monitoring program /
18214